Money neutrality in Taiwan

by

Chun-Chih Hsieh

A Thesis Submitted to the

Graduate Faculty in Partial Fulfillment of the

Requirements for the Degree of

MASTER OF SCIENCE

Major: Economics

Iowa State University
Ames, Iowa

1987

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CHAPTER I. INTRODUCTION

Economists have spent much time and effort studying the business cycle. The business cycle is the more or less regular pattern of expansion and contraction in economic activity around the path of trend growth. At a cyclical peak, economic activity is high relative to the trend and at cyclical trough, the low point in economic activity is reached. Inflation, economic growth, and unemployment are the characteristics of these business cycles. Therefore, the government is expected to moderate business cycles, ideally--to achieve high employment, stable prices, and rapid growth. Monetary policy is one of the two ways to achieve these goals. The other is, of course, fiscal policy.

Recently, there has been a tendency in monetary theory to focus on the impact of nominal money supply changes on real economic activity, especially the distinction between the real short-run impacts of the predictable versus the unpredicted portion of money growth. Robert Lucas, among the new classical macroeconomists, asserts that, under certain conditions, only unanticipated movements in money affect real economy activities (Lucas, 1970, 1972, 1973; Sargent and Wallace, 1975, 1976)--the so-called money neutrality hypothesis. Although many empirical studies have been done, there is no clear evidence showing that money is neutral in every country.

Following recent trends in monetary economics, this paper provides an empirical study of money neutrality on a small open economy (Taiwan).

Barro's strategy (1977) was applied using ordinary least square estimation. The most important distinction between this study and Barro's empirical study is that here data of domestic credits were applied rather than M1 due to the openness of Taiwan's economy. Because multicollinearity interfered with the valid interpretation of the point estimation, only F tests were applied to measure the significance of the money movements. The results indicate that anticipated money movements in Taiwan are not neutral.

Research Objectives

The scope of this study of Taiwan's money neutrality came from both theoretical and policy perspectives. Theoretically, we try to prove that in developing countries with underdeveloped financial markets and excessive government intervention (including the interaction of the fiscal policy and development strategy), money neutrality does not exist. From a policy perspective, we are concerned about whether monetary policies in Taiwan did play an important role in its successful transition from an agricultural to an industrial, from traditional to modern, and from a backward to an advanced economy.

Today, because of the rapid expansion of exports, Taiwan is facing a overly rapid accumulation of foreign exchange which could pose a potential threat to Taiwan's hard-won price stability through its effect on the domestic money supply. An important goal of this study is to determine whether monetary policies were powerful in achieving government goals in the past and how influential they will be in the future (i.e., maintain its high rate of economic growth, stable prices and improvement of income distribution).

General Economy in Taiwan

Taiwan is an island located in southeast Asia that covers a relatively small area (a land area of 36,000 square kilometers, roughly the size of the Netherlands) and is densely populated (nearly 19 million people in 1984). The openness of its economy is evidenced by the share of exports and imports in its GNP as 48.7 percent and 45.7 percent, respectively, in 1981 (Wu, 1985, p. 11).

Since the 1960s, Taiwan has experienced an extraordinarily rapid economic growth:

1960s	9.1% GNP growth rate,
1970s	10.1% (despite two oil-price shocks),
1983	7.9% (U.S. $51.03 billion), and
1984	10.9% (U.S. $57.84 billion) (Council for Economic Planning and Development, 1985, p. 3).

In 1984, per capita GNP reached $3,067 in U.S. dollars. According to Shirley Kuo (1983), much of the credit for Taiwan's economic success is due to its "export-led" growth strategy, under which income generated through exports of labor-intensive, light manufacturing has been translated into capital investment and expanded capacity to produce further exports. Government policies played a very important role in setting all these remarkable records.

Banking system

The Central Bank of China is the monetary authority in Taiwan. The function of the Central Bank is like the Federal Reserve in the United States. Commercial banks serve a wide variety of savers and those with needs for funds, and can be considered the major institutions which handle checking accounts and through which the Central Bank expands or contracts the money. They are also authorized to sell and buy foreign exchange. The government holds nearly half of the shares in every major commercial bank. Also, there is a Postal Savings System which performs contract policy by redepositing to the Central Bank. In addition, credit unions, investment trusts and several branches of well-known foreign banks are also found in Taiwan.

Open market operation

The Central Bank controls domestic credits through the open market. Because the government owns half of the shares of the commercial banks, commercial banks are the most important financial intermediaries between the government and the public.

Dual financial system

"An official money market was established in 1976 to pave the way for more flexible interest rate movements and to channel financial savings from the unorganized private money market to business," according to Shirley Kuo (1983, p. 321). Nevertheless, a well-known unorganized private loan system exists parallel to the official system.

The reason is that government investments in commercial banks are under the supervision of the Supervisory Yuan (a watchdog institution of equal standing to the Executive and the Legislature). A bad debt tends to be interpreted as a loss of a state asset. To avoid bad loans, commercial banks are usually bound by a very strict rules governing collateral; and loan officers usually exaggerate the risks involved in lending to a small, private business or to companies that are not clearly in a favored industry. Since most loan requestors (usually they are small scale businesses) can not meet the collateral required by the banks, private loans with higher interest rates than commercial banks exist to meet their needs.

Organization

Chapter II provides the basic theoretical background relevant to the money neutrality hypothesis. The concepts of natural rate hypothesis, rational expectations, and the role of monetary policy will be discussed. Also, previous empirical studies on money neutrality will be examined. Chapter III specifies the model and data that are adopted in this study. The detailed estimation procedure and test results are reported. In the final chapter, conclusions of this research and suggestions for further research are presented.

CHAPTER II. LITERATURE REVIEW

A major goal of economic policy is to improve cyclical performance by maintaining stable prices, rapid growth and high employment. In order to achieve this goal, governments have at their command two broad classes of policy: fiscal policy and monetary policy. In the United States, monetary policy is controlled by the Federal Reserve System. The instruments of monetary policy are changes in the stock of money; changes in the interest rate (the discount rate) at which the Fed lends money to banks; and other forms of control over the banking system. On the other hand, fiscal policy is under the control of the Congress, and usually is initiated by the executive branch of the government. The instruments of fiscal policy are tax rates and government spending. The present paper is concerned only with monetary policy.

Do changes in the money stock have impacts on economic variables? Is stabilization of monetary policy desired? These questions have been raised by economists and have expanded interest in empirical study for the last two decades. Macro rational expectations models (MRE) were developed in an effort to explain the effectiveness of monetary policy. The MRE models propose the now well-known conclusion that anticipated short-run monetary stabilization policies do not influence real economic variables. Of course, this ineffectiveness proposition is based on a pair of critical assumptions--the existence of the natural rate hypothesis and the rational expectations hypothesis.

The following is a brief literature review examining the natural rate hypothesis, rational expectations, the role of monetary policy, and some previous empirical studies on money neutrality, to form the theoretical background for this empirical study.

Natural Rate Hypothesis

The natural rate hypothesis is derived from the general equilibrium of labor and product markets. In a literal sense, the natural rate hypothesis proposes that given the microeconomic structure of the economy, the behavior of private economic agents is based on approximately correct expectations about the rate of inflation that generate unique levels of aggregate output and employment, denoted as "natural levels."[1] Deviations of output and employment from their natural levels are associated with deviations of expected from actual inflation rates rather than inflation, per se. In other words, the Natural Rate Hypothesis suggests that unanticipated, rather than anticipated, money supply changes influences real economic variables.

The natural rate hypothesis's appearance originated in response to the initial Phillips curve literature. The empirical Phillips curve, based on United Kingdom data from 1861-1957 and analyzed by A. W. Phillips, shows a negative relationship between unemployment and inflation. The Phillips curve implicitly assumes that the trade-off relationship between low unemployment rates and high inflation rates is

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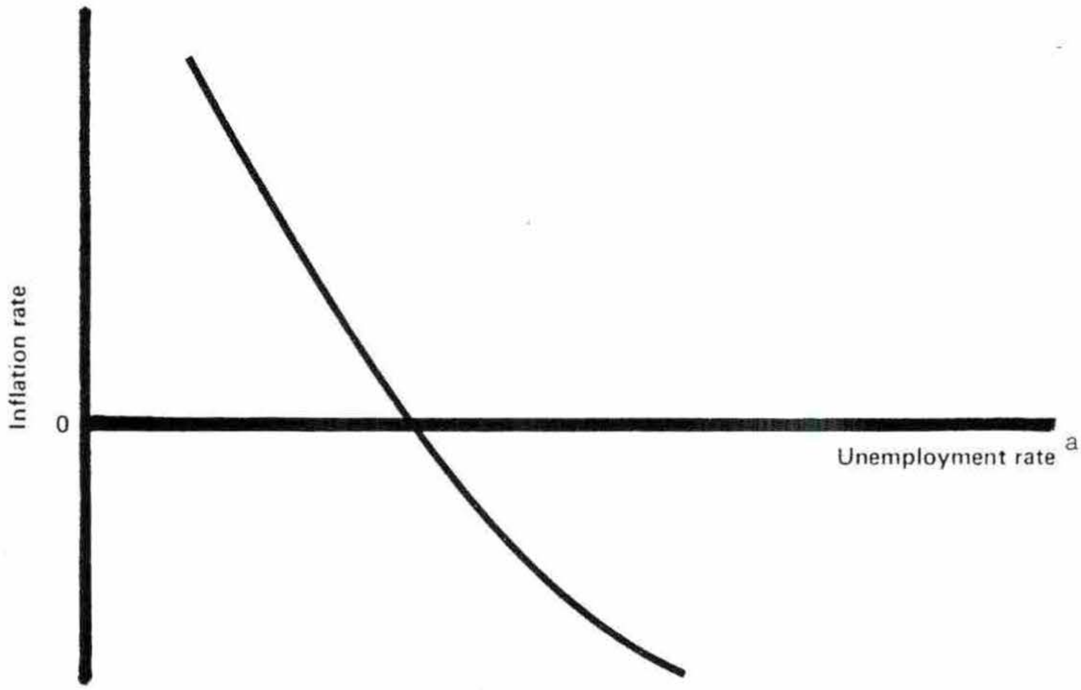
[1]Here, the term private agents refers to households and producers; the term expected inflation rate covers both the expected wage and expected price trends.

independent of both past and current monetary and fiscal policy. Only if policy makers are willing to suffer the high inflation which is associated with the chosen level of output and unemployment, can they reach their desired low unemployment rate (see Figure 2.1). The Phillips Curve was not as stable when United States data was analyzed (see Figure 2.2). To explain why the Phillips curve relationship did not hold for the United States, the natural rate hypothesis was developed by Phelps (1967) and Friedman (1968). The natural rate hypothesis implies that deviations of expected from actual inflation rates will affect unemployment and output levels in the short-run, while the Phillips curve is a vertical line in the long-run at the natural rate. Furthermore, natural rates may vary over time and can be altered by improving technology, increasing capital, or changing the structure of the labor market.

Rational Expectations

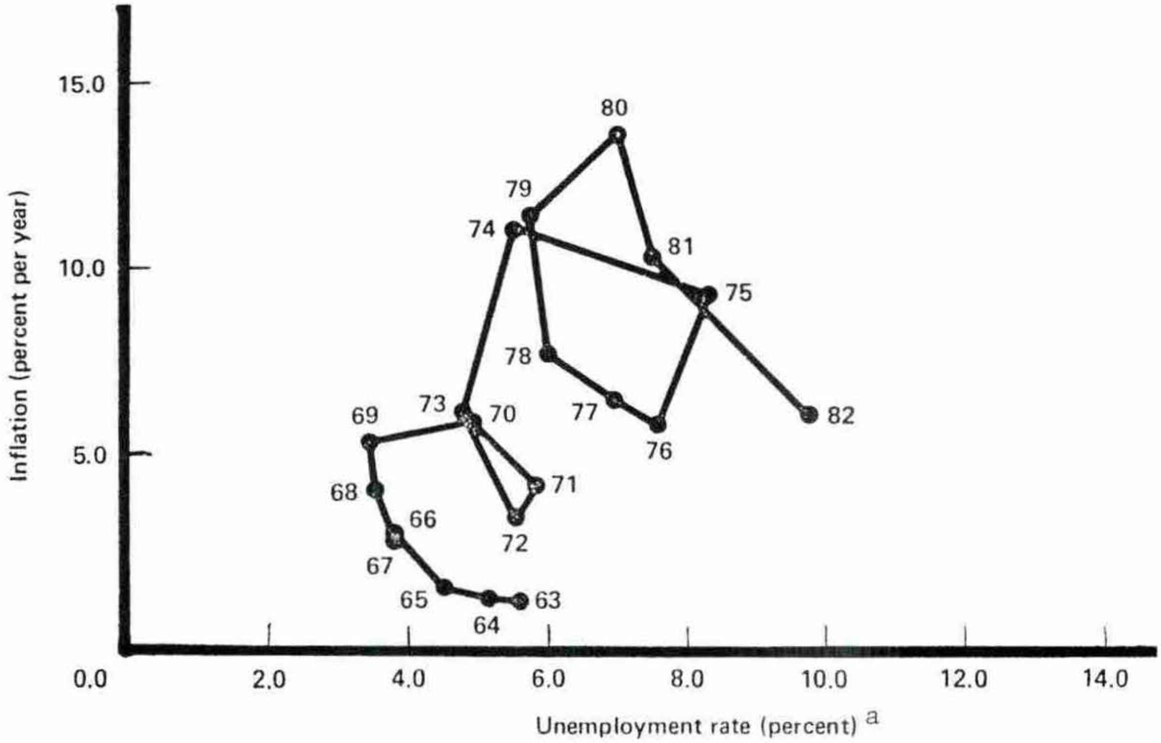
The idea of rational expectations is a recent revolution in macroeconomics. It is distinct from but also complementary to concepts about the relation between government behavior and business cycles. It proposes a general theoretical approach to the study of expectations.

Rational expectation is the application of the principle of rational behavior for individual agents and the government to form and use all obtainable information. Agents do not waste information, and will not make systematic mistakes when forecasting fluctuations in the economy. Models that use this hypothesis have been developed by Lucas (1970, 1972, 1973) and Sargent and Wallace (1976), among others.



[a]The Phillips curve suggests a trade-off between inflation and unemployment. Less unemployment can always be obtained by incurring more inflation--or inflation can be reduced by allowing more unemployment.

Figure 2.1. A Phillips curve



[a]This figure diagrams the actual history of inflation and unemployment in the United States since 1963-1982. The periods of 1963-69, 1976-79, and 1980-82 fit the general shape of the Phillips curve but in between there are periods where inflation and unemployment both increase or sometimes decrease (see Dornbusch and Fischer, 1984).

Figure 2.2. Inflation and unemployment

In general, the rational expectations model has three major concerns. First, it assumes that private agents know the structure of the economy, so that given current and past information they can foresee correctly on average the effects of monetary and fiscal actions. Second, private agents and the government gather and use information efficiently. Efficiency means that the amount of resources agents devote to gathering and using information is such that the marginal alternative cost of resources equals the marginal benefit from the information. In other words, the agents use "all" relevant and obtainable information. The third important component of rational expectation models is the specification of the availability and useability of information, because the ease of assessing information affects the potency of monetary policy. If all policy rules are announced (or are not announced but follow certain rules and are easily observed), rational expectations of the private agents would render monetary policies ineffective. Misspecifications of expectations may lead to monetary nonneutrality in the economy. The above three components are the most important contributions of the rational expectations hypothesis.

Money Neutrality

As mentioned in the last section, the concept of money neutrality comes from the association of the natural rate hypothesis and the rational expectation assumption. Lucas (1973) and Sargent and Wallace (1975) have developed so-called MRE (macro rational expectations) models, and have derived an important neutrality result: because economic agents anticipate changes in aggregate demand policy, government actions will not evoke output or employment responses. The money neutrality hypothesis reflects the controversy that deterministic feedback policy rules will have no impact on output fluctuations in the economy. Contrariwise, the money nonneutrality hypothesis asserts that business cycles do depend in a significant way on an important subset of monetary policies.

Actually, neutrality and nonneutrality are not contradictory. Neutrality does not say that systematic government behavior in general cannot affect aggregate output and employment; monetary policies have not been historically important factors in generating real macroeconomic fluctuations. Rather, neutrality emphasizes only that the systematic part of monetary actions have no effect on the aggregate. It says that economic aggregates will be affected only if the microeconomic structure of the economy is altered to change the natural level of aggregate variables.

As the neutrality hypothesis was the combination of the natural rate hypothesis and the rational expectation hypothesis, it includes several important assumptions: first, private agents know the structure of the economy, and they attach subjective probabilities to the possible effects of perceived or predicted monetary and fiscal actions which are equal to the true probabilities associated with these effects; and second, private agents adjust their behavior in accord with these perceptions so aggregate output and employment satisfy market-clearing levels. These two assumptions imply that private agents form correct expectations about the inflation rate. Given a natural rate, the hypothesis implies that predictable monetary movements do not on average affect the time pattern of differences between actual and natural levels. The third assumption is that the public can perceive systematic responses to business cycle developments even if monetary policies are not announced. The above three assumptions imply money neutrality.

The reasons for money nonneutrality can be outlined as follows:

1. Incomplete information causes incorrect expectations about the rate of inflation. For example, if the government performs policy randomly instead of conducting systematic monetary policies, then the public has no way to form correct expectations; or, due to ignorance, the public may not use all available information and do not form the expectations correctly.

2. Government policies do not perform as expected. The actual performance may be quite different from the desired one. For example, technological problems may cause government plans to go awry. The larger the variance of authority's monetary behavior, the smaller the effects of unpredictable and imperceptible monetary actions on aggregate levels (Lucas, 1973; Barro, 1976).

3. Nonmarket-clearing situations may occur in the economy. This assumption implies that although policy rules are perceivable but not predictable sufficiently in advance, they can affect economic activities (Begg, 1982). For example, if multiperiod wage contracts exist, even

though the public has rational expectations and full information at period t to period t+1, they were locked into period t-1's contract.

Besides the above mentioned reasons, price rigidity and the allocation of traders across markets in each period (Lucas, 1970), and under some particular economic structures, prices convey the real and nominal monetary disturbance only imperfectly, leading money to be nonneutral.

The Role of Monetary Policy

A conventional belief on the importance of monetary policy for stabilization purposes was derived from the Phillips curve. According to that belief, governments can exacerbate or mitigate the business cycles at their will. As mentioned in the previous section, the actual unstable Phillips curve revealed that the relationship between inflation and unemployment are more sophisticated than expected. The natural rate hypothesis, which explained the instability of the Phillips curve, implies that only if the monetary authority can cause the price expectations to deviate from actual price levels can the policy have impacts on real economic variable. Thus, monetary policy may be effective only in the short-run period (Taylor, 1983). In the long-run, agents through trial and error will not make mistakes in forming price expectations.

Now, following the MRE model, economists totally deny the monetary policy role for stabilization purposes. Because MRE assumes agents can perceive the money supply changes, monetary policy is impotent even in the short run. According to the MRE hypothesis, monetary policy will have effects only when it is unexpected, or under other special circumstances. For example, Barro emphasized that besides the MRE assumptions--prices and quantities are competitively determined by market- clearing relationships, and the expectations of future variables are formed rationally--for money policy to be effective, the agent's information should be incomplete, i.e., the government has an information advantage.

The MRE model and its basic algebraic mechanism can be generated as follows:

$$\text{Supply:} \quad Y_t - Y^* = a(P_t - P_t^*) + U_t \tag{1}$$

$$\text{Demand:} \quad Y_t = -bP_t + CX_t \tag{2}$$

$$\text{Expectations:} \quad P_t^* = E[P_t/I_{t-1}] \tag{3}$$

where Y_t = output or unemployment (real economic variables),

Y^* = natural level of aggregates,

P_t = actual prices at time period t,

P_t^* = price expectations,

X_t = government policy instrument; here we only refer to money supply,

I_{t-1} = all information available at time t-1, and

U_t = a "white noise", random error term and $E(U_t) = 0$.

Under the market-clearing equilibrium situation, equation (1) is equal to equation (2).

We obtain the following reduced form equation:

$$P_t = 1/a+b(aP_t^* + CX_t - Y^* - U_t). \quad (4)$$

By the assumption of rational expectations, we get

$$P_t^* = E[P_t/I_{t-1}]$$
$$= E[1/a+b(aP_t^* + CX_t - Y^* - U_t)]$$
$$= 1/a+b[aE(P_t^* + CE(X_t) - E(Y^*) - E(U_t)]$$

substitute in $E(P_t^*) = P_t^*$; $E(Y^*) = Y^*$; $E(U_t) = 0$

$$P_t^* = 1/a+b[aP_t^* + CE(X_t) - Y^*]. \quad (5)$$

Subtracting (5) from (4)

$$P_t - P_t^* = 1/a+b\{C[X_t - E(X_t)] - U_t\}. \quad (6)$$

Put equation (6) to equation (1)

$$Y_t - Y_t^* = a/(a+b)\{C[X_t - E(X_t)] - U_t\} + U_t$$
$$= [aC/(a+b)](X_t - EX_t) + [b/(a+b)]U_t \quad (7)$$

where $X_t - E(X_t)$ is equal to the unsystematic component of government policy. If people with rational expectations know the policy rule, and the government performs the policy following the policy rule, then the term $X_t - E(X_t)$ is a zero-mean random variable. Therefore, the deviations of actual output (or unemployment rate) from its natural level are entirely random. So, the MRE model postulates that anticipated monetary policies are impotent unless the government manipulates the unsystematic component of the monetary policy rule.

Previous Empirical Tests of Neutrality

It is difficult to model and test neutrality within a structural macroeconomic framework. Many macroeconomists have focused on developing tests within the context of reduced-forms of output or unemployment models (Barro, 1977, 1978; Barro and Rush, 1980; Mishkin, 1982, 1983; Hoffman and Schlagenhauf, 1982; and Merrick, 1983).

Robert Barro initiated much of the empirical work on the neutrality hypothesis with a series of papers testing the impact of unanticipated money on aggregate United States output, unemployment, and prices. He first applied annual data and then extended the model to quarterly data.

His model, which is also the general format of tests on the new classical macro neutrality proposition (anticipated money does not affect real output, only unanticipated money matters), specifies real economic activity as a function of anticipated and unanticipated money growth.

As the anticipated and unanticipated components of money are unobservable variables, actual money growth (M_t) was decomposed into its anticipated and unanticipated components in order to complete the test. First, he estimated a money growth model via OLS (Ordinary Least Squares):

$$\begin{aligned} M_t &= Z_t r + \varepsilon_t \\ &= (M_t{}^a + M_t{}^u). \end{aligned} \tag{8}$$

Z_t is a vector of variables relevant to forecasting money growth at time t-1. ε_t is the forecast error and assumed to be uncorrelated with any information available at t-1. Predicted values from the model ($M_t{}^a$) were treated as anticipated money; residuals ($M_t{}^u$) were treated as unanticipated money.

Second, he substituted these anticipated and unanticipated values into the output (or unemployment) equation to estimate the real variable response. The unrestricted reduced form of the response variable is

$$Y_t = \sum_{i=0}^{2} A_i M_{t-i}{}^a + \sum_{i=0}^{2} B_i M_{t-i}{}^u + CX_t + V_t \tag{9}$$

where X_t is a vector of other explanatory variables.

Barro's forecasting model of U.S. money growth was specified as a linear function of past money growth and a set of other predetermined variables. Specifically,

$$M_t = a_0 + \underbrace{\sum_{i=1}^{2} b_i M_{t-i}}_{(1)} + \underbrace{C_1 UN_{t-1} + d_0 FEDV_t}_{(2)} + \varepsilon_t$$

where (1) equals explanatory variables of monetary movement history and (2) equals explanatory variables from business cycle characteristics (only focusing in government's policy).

If we look at his equation more carefully, we find that he generated the money supply movements in the United States in two parts. One is the previous history of money supply itself and the other is from business characteristics of unemployment and a measure of government expenditures relative to normal levels.[1] His study focuses on the central policy rule and ignores other minor factors. For this reason, other economists criticized Barro's model as a reaction function of the central bank. The forecasting model was estimated by OLS to generate the anticipated and unanticipated money portions needed for estimation of the output (or unemployment) responses to monetary shocks.

He also specified the output equation as follows:

$$Y_t = a_1 + \sum_{i=0}^{2} B_i M_{t-i}^{u} + d_1 T + d_2 MIL_t$$

where T is a time trend, and MIL is a measure of military conscription

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[1]FEDV = Log(FED) - [Log(FED)]*. [Log(FED)]* - the normal value of federal expenditures. $UN_{t-1} = \text{Log}[u/(1-u)]_{t-1}$, u = annual average unemployment rate.

(Barro, 1977, pp. 106-107). His results supported the neutrality hypothesis.

Barro and Rush also performed a quarterly test of the above equation and found that unanticipated money had a statistically significant positive impact on output and a negative impact on unemployment. The results from Barro and from Barro and Rush were interpreted as a strong confirmation of the new classical macroeconomic proposition, and the empirical evidence supported money neutrality. The results were taken to indicate that unanticipated money growth significantly affected real economic variables, but they also spurred the controversy and further empirical testing. Mishkin's critique has generated the most interest.

The main difference between the Mishkin and Barro procedures concerns the econometric methodology. Barro's two-step method assumes the parameters estimated in the money growth equation (equation (8)) are the true parameter values when he estimates the output equation (9), ignoring the possible covariance of the parameters estimated in the two equations. If the covariance is nonzero, then the two-stage estimates are not efficient. The standard error and t-statistics will not be theoretically appropriate; but the parameter estimates in the two-step procedure are still consistent.

Mishkin's test of the anticipated money neutrality jointly estimates the money and output equations as a simultaneous system. It then allows for information crossovers between equations while estimating the parameters and provide more efficient estimates of the A_i, B_i and C in equation (9). He used an aggregate level of U.S.

output data, and in particular he also used long lags--twenty quarters. The results showed that in the longer lag model anticipated money neutrality was rejected, while in the shorter lag length model neutrality of anticipated money still held.

Following Darby's attempts to test whether anticipated changes in monetary policy are neutral across countries (the first empirical study outside the United States), Hoffman and Schlagenhauf (1982) tested money neutrality on aggregate real output for six countries. Their approach basically follows Frederic Mishkin's methodology; mixed results were obtained from those countries which included Canada, Germany, Italy, Japan, the United Kingdom and the United States.

However, reasons for money nonneutrality in each individual economy are different, so numerous models have been presented. There is no clear empirical confirmation or contradiction of the theoretical proposition that anticipated money growth is neutral. And should monetary policy makers wish to manipulate policies, it is a very important task for them to find the status of money neutrality for their own economy's structure. The money neutrality hypothesis is theoretically and empirically a current issue.

Barro's strategy is the simplest and most consistent one in testing the money neutrality hypothesis; therefore, the research presented here follows his framework to empirically test for the neutrality of money in Taiwan's economy.

CHAPTER III. EMPIRICAL WORK

The hypothesis that forms the basis of this empirical study is that only unanticipated movements in money affect real economic variables--the so-called money neutrality hypothesis.

Neutrality means that through monetary policy a change in aggregate demand, incorporated into the agents' behavior (anticipated), will provoke no output or employment response. This result implies that any deterministic feed back policy rule (anticipated) is as good as any stabilization policy rule. Until recently, empirical studies have not given clear evidence to support the hypothesis of anticipated money neutrality. According to some economists, monetary policy may have nonneutral effects on the real economic variables (Mishkin, 1982; Hoffman and Schlagenhauf, 1982).

The purpose of this empirical study is to test whether data from Taiwan supports the neutrality hypothesis. The model here basically includes two types of equations: a monetary growth equation, and a real output equation.

Model Set-Up

Money growth equation

In order to test the neutrality hypothesis, it is necessary to differentiate both anticipated and unanticipated components of monetary movements. The first step is to specify a money growth equation using all relevant information (incorporating rational expectations) to forecast money movements one period ahead as the anticipated money. The residuals from this equation are taken as the unanticipated component of money. The equation is

$$DM_t = DM_t + \varepsilon_t = Z_t r + \varepsilon_t$$

where DM_t is the actual growth rate of the money stock, and Z_t is a vector of exogenous and (or) predetermined variables. Actually, the above equation is based on the hypothesis that the growth rate of money stock has been systematically related to (or determined by) a set of observed variables, say Z_t. In addition, there is a component ε_t which is random or unpredictable. Should economic agents rationally form expectations about monetary growth, then the predicted money growth will equal Z_t. Therefore, the unanticipated money growth will be $\varepsilon_t = DM_t - DM_t$. This model has been applied by Mishkin (1982) and Barro (1976).

In this study, the information vector Z_t is formed by variables of government expenditures, lagged values of real GNP, and lagged values of money growth itself. The form is

$$DM_t = a_0 + \sum_{i=1}^{6} a_i DM_{t-i} + a_7 FEDV_t + a_8 Y_{t-1} + a_9 Y_{t-2} + \varepsilon_t.$$

Real output equation

Typically monetary nonneutral effects are considered based on the changes of the unemployment rate, or real output. We only consider one variable--output. Output is chosen as the dependent variable because the unemployment rate in Taiwan is too low and too stable to be sensitive enough for us to test the neutrality hypothesis.[1]

The basic form of the output equation is

$$Y_t = Y_t^n + U_t$$

where Y_t is log (real GNP), and is viewed as consisting of two components: a natural level (Y_t^n) and a transitory or cyclical level (U_t) of output. In this study, the natural rate of output is explained by a constant, a time trend and seasonal adjustment variables. The transitory part of output includes lagged values of itself (U_{t-1}, U_{t-2}, ...) and the impacts from anticipated and unanticipated money movements.

In the econometric procedure, we regress quarterly Y_t on time-trend variables T, T^2, and T^3; seasonal adjustment variables D_1, D_2, and D_3; and an intercept. Then the estimated value of Y_t is subtracted from the actual Y_t to get transitory output--the

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[1]In Taiwan, the unemployment rate is low and stable as a result of cultural characteristics. People are diligent workers and are embarrassed to receive subsidy. Although low income subsidies are available, no unemployment benefits are provided. Finally, unemployment statistics are defined differently than in the United States; the standards for self-employment are different.

residuals U_t. This transitory output is the dependent variable in a regression on the monetary factors and lagged values of itself without an intercept. U_t need not be completely random, because we expect it to be affected by unanticipated monetary growth and perhaps serial dependence or lagged adjustment on lagged value of transitory output itself. So, more precise descriptions of the output equations in this study are

$$Y_{1t} = \text{Log(real GNP)}_t,$$

$$Y_{1t} = b_0 + b_1 D_1 + b_2 D_2 + b_3 D_3 + b_4 T + b_5 T^2 + b_6 T^3 + U_t, \qquad (10)$$

$$U_t = Y_{2t} = Y_{1t} - \hat{Y}_{1t},$$

$$Y_{2t} = \sum_{i=0}^{4} C_i DMR_{t-i} + C_5 Y_{2(t-1)} + V_t. \qquad (11)$$

Variable Construction

The Barro series of empirical studies in 1977 and 1978 were a major breakthrough in testing money neutrality. Although there have been some criticisms of his work, no more simple and better strategies to test money neutrality exist. This study basically replicates Barro's strategy although the variables have been modified as needed.

Monetary growth equation

Domestic credit   Barro's model, unlike this thesis, was developed for a closed economy. He used nominal money supply (M1) to analyze the changes in monetary growth. In an open economy, with fixed or a dirty floating exchange like Taiwan, the nominal money supply is endogenous (Blejer and Fernandez, 1980, p. 87). However, domestic credit contains claims on the government, claims on private enterprises, and claims on government enterprises all of which are under the authority of the government, so that we can treat domestic credit as an instrument of monetary policy in Taiwan. Therefore, domestic credit rather than M1 is the dependent variable in the monetary growth equation. The monetary growth variable can be denoted as follows:

M = domestic credit,

$DM = Log(M_t) - Log(M_{t-1})$.

Government expenditure variable (FEDV)   Because government expenditures are financed by debt creation, taxes, and money issue, all of which can change the monetary growth rate, we take a measure of government expenditures as one of the independent variables in the monetary growth equation. The variable FEDV is denoted as

$$FEDV = Log(FED) - [Log(FED)]^*$$

where FED = nominal government expenditure/GNP deflator = real GNP, and

[Log(FED)]* is the "normal" value of FED. In the other words, FEDV is "extra" government expenditures relative to "normal." And, the normal value [Log(FED)]* is generated from the adaptive formula, used by Barro,

$$[\mathrm{Log(FED)}]^*_t = \beta[\mathrm{Log(FED)}]_t + (1-\beta)\ [\mathrm{Log(FED)}]_{t-1}^*$$

where β's value is chosen from the one with the best fit in the monetary growth equation.

The reason we choose FEDV instead of FED as an explanatory variable is because FEDV captures the revenue motive for money creation. Increases in the federal budget are financed by both money issue and taxation.[1] Over the long run, more tax-raising capital might be invested, lessening the need to finance expenditures through money issue. But in the short run, money issue may be the most timely and convenient way to finance the extra government expenditures. Therefore, only increases in government expenditures relative to normal will induce monetary growth rate changes (Barro, 1977, pp. 101-103). This hypothesis has also been supported by Barro's empirical evidence where he tested the hypothesis that only the difference between Log(FED) and

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[1]Government expenditures are financed by revenues of government debt, taxes, and money issue. Since government debts can be perceived as future taxes (see Barro, 1974), we actually refer to taxes and money issues as the only two means to raise the revenue. We can consider government tax-raising as a micro industry. The amount of capital investment in this industry depends on the "long-run" variables such as government expenditures and national income.

[Log(FED)]* influences money expansion. He used data for 1941 to 1973 from the United States.

Note that FEDV is not normalized, and its average value is not zero.

Measure of lagged real output (Y_{t-1}, Y_{t-2}) The reason for taking lagged values of real output is to think about the monetary response from fluctuations in the business cycle. Money growth might be expected to respond to these variables. For example, there could be a counter-cyclical policy response of money to the level of economic activity. A relatively low lagged value of Y will encourage the government to have an easy monetary policy to stimulate investment. This is called the monetary policy with feedback rule (Barro, 1976).

Lagged values of money growth (DM_{t-i}) Government performance in monetary policy is like the rational behavior of private economic agents in that both learn from previous experience. The lagged values of money growth are the most obvious and easily obtainable information for the government to follow. These lagged dependent variables are used to pick up any elements of serial dependence, or lagged adjustment that have not been captured by the other independent variables.

Only six lags are considered (see Barro's empirical study on two lagged annual data).[1] Of course, some of the insignificant lags may be eliminated according to standard econometric principles.

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[1]Actually, following Barro's empirical study, eight lags are applied. Estimated coefficients of the last two lags turned out to be insignificant. Therefore, only six lags are used.

From the above variables, the monetary growth equation form is

$$DM_t = a_0 + \sum_{i=1}^{6} a_i DM_{t-i} + a_7 FEDV_t + a_8 Y_{t-1} + a_9 Y_{t-2} + \varepsilon_t . \qquad (12)$$

Therefore, the unanticipated monetary growth part will be

$$DMR_t = DM_t - EDM_t$$

where DMR = unanticipated monetary growth,

DM = actual monetary growth,

EDM = estimated value from equation (12),

= anticipated monetary growth.

Real output equation

Seasonal adjustment dummy variables (D_1, D_2, D_3) and time trend variables (T, T^2, T^2) The seasonal adjustment dummy and time trend variables are used to capture the secular movement of "normal" output. The three time trend variables--T, T^2, and T^3--are included in the output equation as indicated by a residual plot.

D_1, D_2, and D_3 are dummy variables which are equal to one (and zero otherwise) when the second, third and fourth quarter data are applied, respectively (Johnston, 1984, p. 234). All observations on the variable Y_1 are quarterly time series without adjustment and are likely to display a seasonal movement. For example, at the Chinese New Year in Taiwan, just as in western countries at Christmas time, the demand for goods increases. The dummy variables are used to get a deseasonalized series of real output.

Transitory output (Y_2) Y_2 is the real output induced by monetary shock or the lagged value of itself. Y_2 is obtained by removing the time trend and seasonal movement from output. In other words, the Y_2 values are the residuals in equation (10): $Y_{1t} = b_0 + b_1D_1 + b_2D_2 + b_3D_3 + b_4T + b_5T^2 + b_6T^3 + U_t$ (see model set-up section).

Contemporaneous and lagged values of monetary growth movement Based on our hypothesis that only unanticipated money affects real economic variables, the unanticipated money variables (DMR) are, of course, the most important explanatory variables of transitory output. The inclusion of lagged values of DMR implies that the persistent output effects from money shock will be carried forward into future periods through stock variables such as productive capital.

Lagged value of Y_2 Previous transitory output may have positive effects on contemporaneous real output. If the previous Y_2 is relatively large, increasing productive capital accumulation, persistent effects of lagged Y_2 values on current levels will be evident. For this reason, we use lagged Y_2 as one of the explanatory variables in the real output equation.

Given all the above mentioned variables, the two output equations are as follows:

$$Y_{1t} = b_0 + b_1D_1 + b_2D_2 + b_3D_3 + b_4T + b_5T^2 + b_6T^3 + U_5 \qquad (13)$$

$$Y_{2t} = U_t = Y_{1t} - \hat{Y}_{1t}$$

$$Y_{2t} = \sum_{i=0}^{4} C_i DMR_{t-i} + C_5 Y_{2(t-1)} + V_t \tag{14}$$

Data Utilized

The sample period covered for this study is 1973 to 1985. Quarterly data were used. Thus, the entire data set contains 52 observations. The data required to study monetary growth and real output here are 1) domestic credit, 2) GNP, 3) nominal government expenditures, and 4) the GNP deflator.

Domestic credit data are published in Financial Statistics Monthly, Taiwan District by the Economic Research Department of the Central Bank of Taiwan. Domestic credit data are collected monthly and are categorized as follows: claims on the government, claims on government enterprises, and claims on private enterprises. Therefore, the domestic credit variables were constructed by calculating the average for each three-month period and adding the averages for each of the above items to get quarterly data.

GNP, the GNP deflator, and government expenditure data were obtained from several issues of Quarterly Income Statistics in Taiwan Area by the Directorate-General of Budget, Accounting and Statistics. The GNP deflator uses 1981 as the base year.

Empirical Results and Discussion

Monetary growth equation

Choice of β All data for estimating the monetary growth equation are available except FEDV. Hence, prior to estimating the monetary growth equation, we need a β value to get FEDV. Barro did not clearly explain how to choose β value for the adaptive formula of [Log(FED)]*. Here, several β values were arbitrarily chosen for the money growth equation that was explained in the last section. Explanatory variables of lagged real output were excluded because they eventually turned out to have insignificant coefficients. The relevant values of R^2 and the Durbin-Watson statistic are reported in Table 3.1. Because all Durbin-Watson values are very close to 2, we may assume that autocorrelation is not a serious problem. Thus, the β values can be selected simply by comparing the R^2 values to determines which specification of the money growth equations provides the best fit.

Table 3.1. R^2 values of DM equation with different β values

	R^2	D.W.
0.05	0.6181	1.947
0.10	0.6780	1.935
0.15	0.6843	1.921
0.20	0.6790	1.912
0.25	0.6737	1.916
0.30	0.6566	1.950

where $FED = Log(real\ GNP)$,

$$DM_t = a_0 + a_1DM_{t-1} + a_2DM_{t-2} + a_3DM_{t-3} + a_4DM_{t-4} + a_5DM_{t-5} + a_6DM_{t-6} + a_7FEDV_t + \varepsilon_t,$$

$$FEDV = Log(FED) - [Log(FED)]^*, \text{ and}$$

$$[Log(FED)]^*_t = \beta[Log(FED)]_t + (1-\beta)[Log(FED)]^*_{t-1}.$$

Figure 3.1 traces the R^2 trend responses to β values between zero and one. We find that when β is less than 0.15, R^2 increases as β increases; and when the value greater than 0.15, R^2 decreases as β increases. Therefore, a β value of 0.15 was selected because the highest value of R^2 was reached at that point (see Figure 3.1). Once the β value was set, the FEDV values were calculated and are listed in Table 3.2. A SAS program was used to construct the FEDV values.

Selection of explanatory variables Once the FEDV variable is constructed, we can estimate the monetary growth equation. First, I ran regressions on three variables: FEDV, lagged values of Y and lagged values of DM, all of which were defined in the previous section. The purpose of regression analysis is to determine whether the variables explain movements of monetary growth. As explained in the previous section, the adaptation coefficient $\beta = 0.15$ was used in the adaptive formula for normal value of government expenditures: $[Log(FED)]_t^* = \beta[Log(FED)]_t + (1-\beta)[Log(FED)]_{t-1}^*$. The estimated coefficients are estimated coefficients are shown in Table 3.3.

The t-ratios show clearly that DM and FEDV perform well as explanatory variables. However, the lagged Ys have many insignificant coefficients, throwing doubt on their explanatory power in the equation.

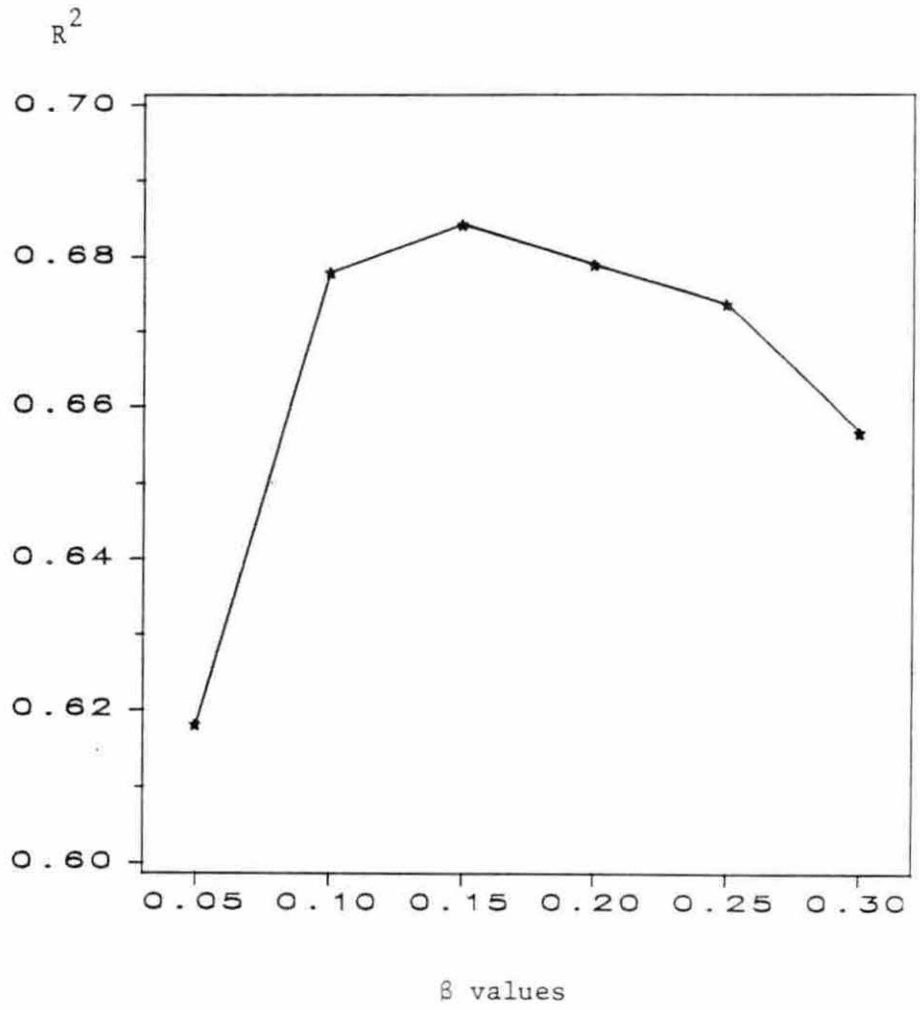

Figure 3.1. R values of DM equation with different β values

Table 3.2. Value of government expenditures (β = 0.15)

Year	FED	FEDV	Year	FED	FEDV
1973.1	349.09	0.0000	1981.1	713.94	0.1676
2	435.34	0.1877	2	714.57	0.1432
3	320.70	-0.1002	3	692.87	0.0955
4	324.55	-0.0751	4	695.09	0.0839
1974.1	309.49	-0.1024	1982.1	785.20	0.1749
2	331.54	-0.0301	2	774.00	0.1365
3	346.39	0.0117	3	752.77	0.0924
4	345.16	0.0069	4	747.61	0.0727
1975.1	375.57	0.0776	1983.1	811.72	0.1317
2	399.24	0.1180	2	810.76	0.1109
3	367.47	0.0298	3	785.09	0.0670
4	419.58	0.1380	4	775.43	0.0464
1976.1	415.26	0.1085	1984.1	860.73	0.1281
2	420.11	0.1021	2	845.34	0.0936
3	424.46	0.0956	3	878.31	0.1121
4	453.94	0.1383	4	853.24	0.0706
1977.1	463.07	0.1345	1985.1	924.79	0.1285
2	469.89	0.1267	2	929.82	0.1138
3	460.44	0.0905	3	937.01	0.1033
4	536.74	0.2072	4	934.49	0.0855
1978.1	525.50	0.1582			
2	541.92	0.1606			
3	491.36	0.0532			
4	575.94	0.1803			
1979.1	564.79	0.1366			
2	564.23	0.1153			
3	597.19	0.1462			
4	629.53	0.1678			
1980.1	646.75	0.1669			
2	638.05	0.1304			
3	649.37	0.1258			
4	669.08	0.1323			

Table 3.3. Estimated DM equation: $DM_t = a_0 + a_1DM_{t-1} + a_2DM_{t-2} + a_3DM_{t-3} + a_4DM_{t-4} + a_5DM_{t-5} + a_6DM_{t-6} + a_7FEDV_t + a_8Y_{1(t-1)} + a_9Y_{1(t-2)} + a_{10}Y_{1(t-3)} + \varepsilon_t$

Variables	Coefficient (1)	T-ratio	Coefficient (2)	T-ratio
Intercept	-0.019	-0.132	-0.003	-0.021
DM_{t-1}	0.511	3.508*	0.516	3.558*
DM_{t-2}	0.111	0.764	0.085	0.601
DM_{t-3}	-0.230	-1.829	-0.245	-1.968
DM_{t-4}	0.297	2.068*	0.320	2.285*
DM_{t-5}	-0.017	-0.109	-0.066	-0.447
DM_{t-6}	0.238	1.883	0.265	2.173*
$FEDV_t$	0.166	3.062*	0.175	3.305
$Y_{1(t-1)}$	0.071	0.993	0.049	0.737
$Y_{1(t-2)}$	-0.011	-0.141	-0.051	-0.807
$Y_{1(t-3)}$	-0.063	-0.862	-	-

*Significant at the five percent significance level.

Therefore, joint F-tests of $a_8 = a_8 = a_9 = 0$ in equation (1) and $a_8 = a_9 = 0$ in equation (2) on Table 3.3 were applied. As shown in Table 3.4, the F values were 0.4842 and 0.3573, respectively. As both F values are smaller than the critical values of 2.88 and 3.27, we failed to reject the hypothesis that lagged values of output do not have impacts on contemporaneous monetary growth rates. As a result, our money growth equation contains only two kinds of explanatory variables--FEDV and lagged values of monetary growth (DMs).

<u>Deletion of insignificant lagged variables of DM</u> Once the lagged real output variables are excluded, the monetary growth regression equation was estimated solely depending on FEDV and DM's as:

$$DM_t = -0.020 + 0.518DM_{t-1} + 0.065DM_{t-2} - 0.197DM_{t-3} + 0.276,$$
$$(-2.234)\ (3.877)\qquad (0.491)\qquad (-1.816)\qquad (2.329)$$

$$M_{t-4} - 0.037DM_{t-5} + 0.275DM_{t-6} + 0.175FEDV_t + \hat{\varepsilon}_t,$$
$$(-0.269)\qquad (2.479)\qquad (3.568)$$

$$R^2 = 0.6843 \qquad D.W. = 1.921,$$

( ) = t-ratio,

where the bracketed figures are the t-ratios for the relevant estimated coefficients. The estimated coefficients of DM_{t-2} and DM_{t-5} are small and the t-ratios are insignificant (see Table 3.5).

Table 3.4. Test results of goodness of fit for the lagged values of GNP

Tests	F-values	Prob. > F
$H_0: a_7 = a_8 = a_9 = 0$	$F^3_{34} = 0.4842^a$ $(F_c = 2.88)^b$	0.6955
$H_0: a_7 = a_8 = 0$	$F^2_{35} = 0.3573$ $(F_c = 3.27)$	0.7021

[a] $F^q_{(n-k)} = \frac{(SSE_R - SSE_F)/q}{SSE_F/(n-k)}$.

[b] F_c = critical F values at the five percent level.

Table 3.5. Estimated coefficients of DM equation without lagged real output

	Coefficient	t-ratio	Standard error	Prob. > T
Intercept	-0.020	-2.234	0.009	0.0316
DM_{t-1}	0.518	3.877	0.134	0.0004
DM_{t-1}	0.065	0.491	0.133	0.6273
DM_{t-3}	-0.197	-1.816	0.108	0.0775
DM_{t-4}	0.276	2.329	0.119	0.0254
DM_{t-5}	-0.037	-0.269	0.138	0.7894
DM_{t-6}	0.275	2.479	0.111	0.0179
$FEDV_t$	0.175	3.568	0.049	0.0010

Following the thrifty principle in econometrics, elimination of both variables from the right hand side of the equation was considered. A joint hypothesis test of $a_2 = a_5 = 0$ was made. The F value was 0.3; the corresponding critical level was 3.21. Because we failed to reject the hypothesis, both DM_{t-2} and DM_{t-5} were removed from the equation. After removing the DM_{t-2} and DM_{t-5}, the F statistic was calculated.[1] It shows that the remaining DMs have significant impacts on DM. Therefore, the final estimated monetary growth equation is

$$DM_t = \underset{(-2.534)}{-0.021} + \underset{(4.715)}{0.523DM_{t-1}} - \underset{(-1.845)}{0.184DM_{t-3}} + \underset{(2.625)}{0.270DM_{t-4}} + \underset{(3.214)}{0.291DM_{t-6}}$$

$$+ \underset{(4.136)}{0.178FEDV_t} + \hat{\varepsilon}_t, \qquad (15)$$

$R^2 = 0.6791 \quad D.W. = 1.914,$

( ) = t-ratio.

Estimated values of DM as anticipated monetary growth (EDM) were obtained from equation (15). Residuals of equation (15) were calculated by subtracting EDM from DM as unanticipated monetary growth (DMR). Results are reported in Table 3.6.

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[1] $F^4_{39} = 8.7440$, and the critical value at the five percent significance level is $F_c = 2.615$.

Table 3.6. Values of DM, DMR, and EDM

Year	DM	EDM	DMR
1973.1	-	.	.
2	0.1103	.	.
3	0.0802	.	.
4	0.0844	.	.
1974.1	0.0889	.	.
2	0.1349	.	.
3	0.0711	.	.
4	0.0691	0.0560	0.0130
1975.1	0.0540	0.0516	
2	0.0851	0.0763	0.0088
3	0.0442	0.0613	-0.0171
4	0.0851	0.0748	0.0103
1976.1	0.0517	0.0626	-0.0109
2	0.0424	0.0593	-0.0169
3	0.0101	0.0304	-0.0202
4	0.0487	0.0473	0.0014
1977.1	0.0587	0.0476	0.0102
2	0.0656	0.0663	-0.0007
3	0.0393	0.0384	0.0009
4	0.0472	0.0515	-0.0043
1978.1	0.0594	0.0385	0.0209
2	0.0645	0.0635	0.0010
3	0.0464	0.0411	0.0053
4	0.0675	0.0565	0.0010
1979.1	0.0656	0.0544	0.0112
2	0.0424	0.0566	-0.0142
3	0.0406	0.0448	-0.0042
4	0.0328	0.0552	-0.0224
1980.1	0.0609	0.0495	0.0114
2	0.0695	0.0578	0.0117
3	0.0586	0.0619	-0.0033
4	0.0472	0.0433	0.0039
1981.1	0.0419	0.0492	-0.0073
2	0.0381	0.0441	-0.0060
3	0.0290	0.0410	-0.0119
4	0.0372	0.0345	0.0026
1982.1	0.0571	0.0511	0.0060
2	0.0461	0.0520	-0.0060
3	0.0406	0.0329	0.0078
4	0.0365	0.0240	0.0125
1983.1	0.0344	0.0371	-0.0027
2	0.0459	0.0327	0.0132
3	0.0364	0.0359	0.0005
4	0.0351	0.0234	0.0117
1984.1	0.0368	0.0330	0.0038
2	0.0315	0.0314	0.0001
3	0.0293	0.0290	0.0002
4	0.0243	0.0231	0.0012
1985.1	0.0101	0.0295	-0.0194
2	0.0201	0.0180	0.0021
3	0.0100	0.0222	-0.0122
4	0.008	0.0135	-0.0055

Real output equation

Regression on real output relative to natural trend The equation of real output relative to its natural trend as specified in the model set-up section, is

$$Y_1 = b_0 + b_1D_1 + b_2D_2 + b_3D_3 + b_4T + b_5T^2 + b_6T^3$$

where Y_1 = Log(nominal GNP/GNP deflator). The estimated equation is:

$$Y_1 = \underset{(0.023)}{7.6680} + \underset{(0.015)}{0.0244}D_1 + \underset{(0.015)}{0.0222}D_2 + \underset{(0.015)}{0.0430}D_3 + \underset{(0.004)}{0.0143}T + \underset{(0.000)}{0.0004}T^2 - \underset{(0.000)}{0.00001}T^3.$$

Figures in parentheses are standard errors. Transitory output data was obtained by using the actual Y_1 minus estimated values of $Y_1(Y_{1t} - \hat{Y}_{1t} = Y_{2t})$.

Regression on transitory output ($Y_{2,t}$) The contribution of monetary policy to transitory output is the key issue in this study. So, the regression of transitory output on the explanatory variables is the focus in testing money neutrality.

The transitory output equation basically contains two explanatory variables--lagged values of transitory output itself ($Y_{2,t-1}$, $Y_{2,t-2}$, ...) and unanticipated monetary movements (and anticipated monetary movements if money is nonneutral).

Lag length for lagged transitory output (Y_2) Lagged values of transitory output are used as explanatory variables due to costly adjustment. For example, last period transitory output may result from monetary movements. Although agents can perceive these changes correctly in the current period, costly adjustment will prevent immediate precise adjustments in productive capital. Therefore, lagged Y_2 may still have persistent effects on contemporaneous Y_2. Two lagged values of Y_2 were put into the equation with monetary shocks as independent variables. The empirical result are reported on Table 3.7.

Table 3.7 shows that the estimate of the $Y_{2(t-2)}$ was not significant, while the coefficient of the lagged value of Y_2 was significant. Therefore, only $Y_{2(t-1)}$ was retained in the Y_2 regression equation.

Lag length for monetary shocks The choice of lag length for the monetary variable was based on the degrees of freedom. Seven observations were lost in estimating the DMRs, so data of DMR (or EDM) only started from 1974:IV; in detrending and seasonally adjusting seven degrees of freedom were lost. The longer the lag length of monetary variables, the more observations and degrees of freedom are lost. Therefore, only contemporaneous and four lagged values of unanticipated (or anticipated) money were used. Estimates of the coefficients are reported in Tables 3.8 and 3.9., and tests of actual money effects, and anticipated and unanticipated monetary effects on output are reported in Table 3.10. The results show that at the 0.05 significance level actual money affected real output, and both unanticipated and anticipated money have impacts on real output.

Table 3.7. Results of Y_2 regression equation

Independent variables	Equation (1)	Equation (2)
$Y_{2(t-1)}$	0.8584 (3.491)[a]	0.7869 (8.994)
$Y_{2(t-2)}$	0.2197 (1.292)	
DMR_t	-0.901 (-0.31)	-0.2347 (-0.878)
DMR_{t-1}	0.0910 (0.346)	0.1535 (0.588)
DMR_{t-2}	-0.0924 (-0.356)	-0.0877 (-0.334)
DMR_{t-3}	0.2792 (1.080)	0.2768 (1.060)
DMR_{t-4}	0.4716 (1.754)	0.4222 (1.571)

[a]Numbers in parentheses are t-ratios.

Table 3.8. Regression Y_2 on DMR (without intercept): $Y_2 = \sum_{i=0}^{4} \alpha_i DMR_{t-i} + \alpha_5 Y_{2(t-1)}$ (i=0,1,2,3,4)

Variable	Coefficient (α_i)	
$Y_{2(t-1)}$	0.7869	(8.994)[a]
DMR_t	-0.2347	(-0.878)
DMR_{t-1}	0.1535	(0.588)
DMR_{t-2}	-0.0877	(-0.334)
DMR_{t-3}	0.2768	(1.060)
DMR_{t-4}	0.4222	(1.571)

[a]Numbers in parentheses are t-ratios.

Table 3.9. Regression Y_2 on EDM (without intercept): $Y_2 = \sum_{i=1}^{4} \beta_i EDM_{t-1} + \beta_5 Y_{2(t-1)}$ (i=0,1,2,3,4)

Variable	Coefficient (β_i)	
$Y_{2(t-1)}$	0.8173	(9.454)[a]
EDM_t	0.3658	(1.205)
EDM_{t-1}	-0.4507	(-1.578)
EDM_{t-2}	0.2040	(0.735)
EDM_{t-3}	-0.2087	(-0.774)
EDM_{t-4}	0.1371	(0.485)

[a]Numbers in parentheses are t-ratios.

Table 3.10. Results from tests of anticipated, unanticipated, and actual money growth impacts

Hypothesis	F value	F_c
No unanticipated money impacts		
$H_0 = \alpha_i = 0$	5.3286	$F_{35}^{5} = 2.485$
(i=0,1,2,3,4)		Reject H_0
No anticipated money impacts		
H_0: $\beta_i = 0$	6.4563	$F_{35}^{5} = 2.485$
(i=0,1,2,3,4)		Reject H_0

Multicollinearity problem

As lagged values of monetary shocks were used in the model, it is very likely that multicollinearity exists between the explanatory variables in both the money growth equation and output equation. The following table (Table 3.11.) reports the simple correlation coefficients between the DMs and FEDV in the monetary growth equation. The correlation between the dependent and independent variables are given in the first row.

Pindyck and Rubinfeld (1981, p. 89) state that "multicollinearity is likely to be a problem if the simple correlation between two variables is larger than the correlation of either or both variables with the dependent variable." The correlation between DM_{t-1} and DM_{t-3} is 0.56342; DM_{t-3} and DM_{t-4}, 0.57903; DM_{t-1} and $FEDV_t$, -0.57094; and DM_{t-3} and $FEDV_t$, -0.36794, and all of these correlations are fairly large. The high correlations reveal that multicollinearity does exist. This collinearity causes the estimated coefficient to be inefficient (it has a large variance of $\hat{\sigma}2(X'X)^{-1}$). When we interpret the statistics, the t-ratios are no longer meaningful, so only a joint F-test was calculated. For the same reason, the individual estimated coefficients of monetary movements (anticipated and unanticipated money) in the Y_2 equation were ignored. Therefore, only the F statistics in Table 3.10. were applied and the above mentioned three findings were reported.

Table 3.11. Correlation coefficients for the variables used in the DM equation (1973:I-1985:IV)

	DM_{t-1}	DM_{t-3}	DM_{t-4}	DM_{t-6}	$FEDV_t$
DM	0.64255	0.41970	0.62643	0.54375	-0.27561
DM_{t-1}	1	0.56342	0.37755	0.36865	-0.57094
DM_{t-3}		1	0.57903	0.32424	-0.36794
DM_{t-4}			1	0.49321	-0.17744
DM_{t-6}				1	-0.23181
$FEDV_t$					1

CHAPTER IV. CONCLUSION

The econometric analysis leads us to the following conclusions:

1. unanticipated money affects the output; and

2. anticipated monetary changes also have impacts on real output.

The first finding was expected from the MRE postulation, and because Taiwan is a developing country, the second finding was also expected.

There are several possible reasons for the second finding, that anticipated monetary changes have impacts on real output. First, interest rates for savings and loans in Taiwan are set by the Central Bank Interest Rate Committee,[1] whereas in the United States interest rates are determined by open market operations. Changes in interest rates will change the macroeconomic structure (i.e., the IS and LM curves) and therefore affect real output.

Second, monetary impacts on real output might be caused by anticipated money movements in conjunction with government development strategy. In the 1970s, Taiwan's economic strategy was designed to encourage backward integration and the development of intermediate goods industries; in the 1980s the development of technology-intensive industries was encouraged. Favored industries get loans easier than other industries, and get lower interest rates than other loans.

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[1]Although the rates were set up according to the supply and demand situation in money markets, both rates are suppressed relatively low compared to the equilibrium level for the purpose of promoting private investments in productive capital.

Structural changes at the micro level affected aggregate demand quantity and thus real output.

The third source may come from the flexibility of relative prices. Taiwan is a small, open, price-taking economy. The prices of its traded goods will be determined independently of domestic monetary movements, so only the price of nontraded goods can be affected by monetary disequilibrium. Monetary expansion will cause the prices of nontraded goods to increase, raising real output in the nontraded goods sector and reducing real output in its traded-goods sector (Blejer and Fernandez, 1980, pp. 82-95).

Suggestion for Further Research

As pointed out in Chapter III the multicollinearity problem interfered with proper interpretation of the t-ratio. If this problem could be corrected, we may be able to explain the relationship between the explanatory variables and real output more properly.[1] And, if the issue of traded and nontraded goods were properly modeled, the money nonneutral effects in Taiwan might be explicitly revealed on the both traded and nontraded goods sectors.

An extension of this study that would give us more valuable economic insights would be to examine effects of monetary neutrality on the individual micro sectors of the economy. For example, the study of the structural changes in individual industries corresponding to

[1]Mishkin's estimation procedure may be a good way to avoid this collinearity problem.

monetary shocks could give the government a direction to approach its economic development goal and provide more information in price and quantity determination to individual industries.

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ACKNOWLEDGEMENT

There are many to whom I owe more than simple thanks for their help and advice on this thesis. First, I would like to express my appreciation to Dr. Douglas Catron for his guidance in writing. Special thanks are extended to my dear friends Joanne Geigel and Zong-Shin Liu for their advice and continual support, and most importantly for their friendship. I would also like to thank my major professor, Dr. Barry Falk, and the other members of my committee, Dr. Walter Enders and Dr. Roy Hickman. I thank Diana McLaughlin for her expert typing; without her, I could not have completed this paper so smoothly.

Finally, I wish to express my deepest gratitude to my father for his understanding and loving support, and for the never-ending encouragement my family has given me during my study at Iowa State University.